

Not Fade Away?

Commentary to paper *Education and The Semantic Web* (IJAIED Vol.14, 2004)

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Abstract If you ask me “Will Semantic Web *ever* happen, in general, and specifically in education?”, the best answer I can give you is “I don’t know, but I know that today we are still far away from the hopes that I had when I wrote my paper *Education and The Semantic Web* (Devedzic 2004) more than 10 years ago. Much of the things from that paper are today obsolete, but some remain. With the experience gained and lessons learned over time, as well as with many other developments in the general field of Web-based education, it is possible to sketch a much more realistic picture about Semantic Web and its implications for education than it was possible back then. This article attempts to capture that picture by discussing a diagram.

Keywords Semantic Web · Ontology · Education

Prelude

In his 2014 interview given to *Real Business*, Milan Stankovic, a well-known researcher and practitioner in the field of Semantic Web, explains in simple words what Semantic Web is (Flanagan 2014): “... a new way of structuring data so that machines can understand them. For instance, if you’re seeking information about Paris, your computer doesn’t know what Paris really is. It doesn’t know if ‘Paris’ is the capital of France, a city in Texas, or the Hilton heiress. With Semantic Web, not only would it understand the difference between these concepts, but it would also make sense of them: Paris is a city, which is the capital of France, which is a country in Europe, etcetera.”

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Obviously, if our networked computers can *themselves* interpret and present knowledge and information that way, positive implications for education are unquestionable. Semantic Web is about how machines can automatically process the *meaning* of data, not the structure; thus in education, it can scaffold appropriate content presentation, search, adaptivity, personalization, context awareness, and other aspects of the learning process.

Over the years, many Semantic Web technologies (often called just Semantic technologies) have been developed and standardized. The most important ones today are: RDF (Resource Description Framework), the language for modeling data and representing, storing and interchanging information (W3C 2014); SPARQL protocol and RDF query language (W3C 2013); and OWL (Web Ontology Language), the schema/concept definition (knowledge representation) language (W3C 2012) that enables specification of concepts so that they can be selected, reused, connected (assembled) with other concepts to define more complex ones, in different contexts and applications. They are all supported by appropriate tools.

My thoughts from the abstract of this article are illustrated by the diagram shown in Fig. 1 and are elaborated in the rest of the article. The diagram is a variant of the Gartner’s Hype Cycle (http://en.wikipedia.org/wiki/Hype_cycle) and holds not only for Semantic Web, but also for a number of other technologies (not only in education).

Wishing Well

I wrote *Education and The Semantic Web* and several other papers because I was fascinated with the idea of ontologies. I first learned about it from the well-known Tom Gruber’s paper (1992). Then I attended Riichiro Mizoguchi’s talk on task ontology at my very first AIED conference in Kobe, Japan, 1997 (his ideas can be seen in, e.g., (Mizoguchi et al. 1996)). I was mesmerized! The very idea of ontology as a formal “specification of a conceptualization”, i.e., the idea of representing all concepts, relations between them, and knowledge that emerges from these concepts and relations was... Woooww!!! The Web was already there as the infrastructure to support it, I thought, and Tim Berners-Lee and W3C were already conceptualizing and developing the supporting specifications and technology (Berners-Lee et al. 1999).

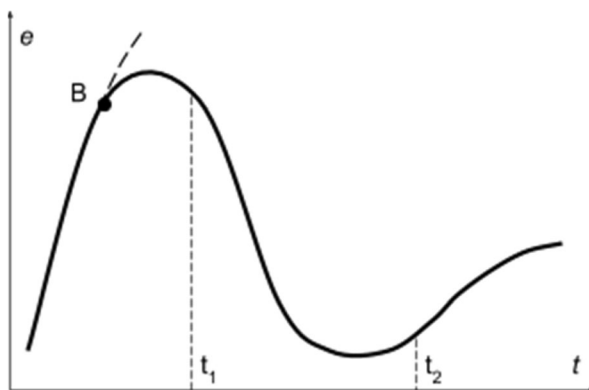


Fig. 1 How enthusiasm for Semantic Web in education has changed over time

Here I'm talking about the very first section of the diagram in Fig. 1, somewhere from the diagram origin (called *the technology trigger* in the Gartner's Hype Cycle) to the "breakpoint" B (close to the top of the diagram, i.e., to the *the peak of inflated expectations*), the time when many of us who have jumped on the Semantic Web train in late 1990s believed that Semantic Web will happen in a foreseeable time and will transform everything, including education. That's the dashed line beyond point B. There would be educational agents and educational servers everywhere, I believed, and educational content would be "flowing out like endless rain into a paper cup" from authoring tools designed upon and supported by Semantic technologies.

I felt it was my duty to write *Education and The Semantic Web*, because of the fact that many of my friends from the AIED community have realized the importance of *intelligent* interaction between the learner and the content, the learner and the peer learners, the learner and the teacher, and so on. Since I was coming from the technological side of Web-based education and AIED in general, not from the pedagogical one, I wanted to contribute to the community by promoting the technology that seemed to me to be the most promising one at the time. So in that paper I took the approach of surveying the most important technologies and providing a number of examples of possible ways to use them in education. I was focusing on how to use the *existing* technology (that-time ontology languages and development tools, that-time semantic annotation techniques, pedagogical agents), without waiting for the new one to come (e.g., tagging and folksonomies, controlled vocabularies, RDFa, and the like). I still see nothing wrong with that approach, but perhaps some of the examples I used could have been different.

Expecting to Fly

The problem with point B is that it is difficult to sense it when it is reached. Inertia usually prevails at that point, and those who wholeheartedly ride the wave and follow its idea/developments/hype fail to notice that the things have started to diverge from the dashed line that they have projected.

But that time, from point B to somewhere around time t_1 , is often so cool—our beliefs are still strong, our energy is high, and so are our expectations. Most of all, we are very creative during that time. I myself felt very creative and was very enthusiastic at that time about how ontologies and Semantic technologies can change education. I was even "preaching" and "evangelizing" it among my students and fellow researchers. I think that the core contributions of *Education and The Semantic Web* were:

- the idea of what I then called *educational server* (with ontological underpinnings)
- the definition (vision) of educational services an educational server should provide (educational content search and retrieval, personalization and learning path creation, support for both individual and collaborative learning, and the like)

I still think that, in a way, these ideas *did* capture important learners' needs and that some of the challenges they indicated were subsequently implemented (albeit independently, and by many other researchers, groups, institutions and educators, and mostly without Semantic technologies). With some openness and flexibility, one can notice the

same ideas in Personal Learning Environments, PLEs (Attwell 2007), Open Educational Resources, OERs (OECD 2007), and, to an extent, even in Massive Open Online Courses, MOOCs (Pappano 2012).

While reading *Education and The Semantic Web* again after more than 10 years, one fact struck me instantly: many references used in that paper are from 2002 or were written during 2002. Then I browsed the list of my own publications and noticed that I myself was writing a lot about Semantic Web (both in general, and in education) in 2002. Thus in my mind I dubbed this section of this article Summer of Love 2002.¹ Effects of the work I have done in 2002 have extended over a couple of years after 2002 and have brought me nice professional and research results and recognition that I'm still proud of: an invited talk on Semantic Web and education at the 3rd Annual ARIADNE Conference; a tutorial on education and Semantic Web that I gave at AIED 2005; a Springer monograph (Devedzic 2006); etc.

Waiting for Godot

As a researcher, I have always had a “parallel life”; I still have it: in addition to AIED, I also like software engineering (SE). It was probably the main reason why I have recognized the t_1 point in time on the diagram and the gradient of the diagram beyond that point. In this case, t_1 came somewhere around 2005–2006.

Imagine As the time was going by and Semantic Web was not taking over as it was expected, I was noticing more and more that in publications on Semantic Web the word “imagine” and its synonyms were very popular. Ironically, even today, when the term “Semantic Web” is getting more and more replaced by the less glorious “Linked Data”, “Web of Data”, and the like, there is a lot of “imagine”. For example: “Imagine hundreds of different data sets published on the Web according to the Linked Data principles: thousands and thousands different identifiers you can rely to grab data about books, movies, actors, cities, or anything you can imagine. In few words, such datasets form a giant Web-scale database you could potentially embed in your applications and reference whenever you needed.” (Palmisano 2014) In SE, “imagine” does not last for years; it either quickly turns into “there *is*”, or fades away even more quickly.

Dancing in the Dark Developing ontologies is anything but easy. Some of us have been doing great work and were putting a lot of effort in building useful educational ontologies, those that I was expected in my 2004 paper to start popping up much more easily. But Dragan Gasevic et al. (2011) have realized that ontology development and maintenance remain the key research challenges to be solved before ontology-enhanced learning environments become widely adopted and used. To help alleviate this situation, they have developed an approach to ontology maintenance based on the use of collaborative tags contributed by learners while using learning environments.

Among the best known research efforts to be acknowledged here is the work of Riichiro Mizoguchi, Jacqueline Bordeaux, and their students and associates who have been building their OMNIBUS ontology of learning, instruction and instructional

¹ With obvious reference to Summer of Love 1967. If you're not sure what it was, just Google it.

design for years (OMNIBUS project 2012). SMARTIES, the world-first authoring system that helps authors develop theory-compliant learning scenarios, is built on top of OMNIBUS (Hayashi et al. 2009).

In addition, several other projects, initiatives and consortia have been putting a lot of efforts in developing and deploying online learning resources and ontologies and Semantic technologies to improve annotation of digital learning resources and their retrieval. These include the ARIADNE Foundation (<http://www.ariadne-eu.org/>), MERLOT (<http://www.merlot.org/>), LORNET (<http://www.lornet.org/>), GLOBE (<http://globe.edna.edu.au/globe/go>) and LUISA (<http://www.luisa-project.eu/www/>).

Another good example is the work of Jelena Jovanovic, who has developed a number of ontologies and several ontological frameworks and tools. For example, her LOCO-Analyst is a generic feedback provisioning tool based on Semantic technologies and analysis of learning context data captured and integrated from online learning systems and tools (Jovanovic 2008). It enables teachers to rethink the content and structure of their courses and helps them customise the courses to the students' needs.

Zoran Jeremic and his colleagues have studied how a PLE can be improved if it is made aware of the learner's online presence (Jeremic et al. 2012). They have developed a software solution based on a synergy of Semantic technologies, online presence and socially-oriented learning theories, and relies on the ontology of online presence. This ontology is originally developed by Milan Stankovic for modeling the dynamic aspects of a user's presence in the online world and enabling exchange of the online presence data (<http://online-presence.net/>).

But efforts like these were obviously ahead of their time. It seems that they were just too advanced to become popular with ordinary researchers, let alone industry. Generally, in the $[t_1, t_2]$ interval on the diagram, there was *very* little interest (and very little understanding) in industry for Semantic technologies. It was still almost purely academic. I think that the bottom of the diagram (called *the trough of disillusionment* in the Gartner's Hype Cycle) happened somewhere around 2011. At that point, a SE mind would always ask: how many successful, widely-used, Semantic Web applications in education do you know of?

The Thrill is Gone It was getting more and more obvious, even at W3C, that the original vision of Semantic Web had a number of issues and that it will take long to implement it (W3C 2006). Semantic Web specifications and technology were not used much in practice, easy semantic annotation of educational content has proven to be an illusion, and Web 2.0 (Social Web) has come and has speeded up the decline of interest in Semantic Web.

Down to the Crossroads, Tried to Flag a Ride

After the $[t_1, t_2]$ hangover, those in our community who were still interested in the Semantic Web have reduced their ambitions and have tried to root their interest in the new reality. The Gartner's Hype Cycle refers to this period on the diagram as *the slope of enlightenment*. It is followed by a relatively stable period called *the plateau of productivity* (the last section of the diagram), where parts of the corresponding

technology (Semantic technologies, in this case) have entered / are entering a mainstream use (in this case, in education).

During these two periods (roughly, from Late 2011 to present days), instead of developing complex ontologies with a lot of rigorously specified relationships, researchers have started relying on still formal, but less strict and less complex *controlled vocabularies*; they are different from, but also often related to *folksonomies* emerging from social tagging (Giordano et al. 2011). In addition, a new term, *Linked Data*, was coined by Tim Berners-Lee to denote a simpler version of the Semantic Web, where RDF, SPARQL and other Semantic technologies are used to create links between different machine-readable data sets on the Web, thus making them interrelated. W3C now explicitly says that Semantic Web is a *Web of Data* (<http://www.w3.org/standards/semanticweb/data>).

The huge impact of Web 2.0 was further recognized by merging its practices and Semantic Web ones into *Social Semantic Web* (Mikroyannidis 2007). Nowadays many educational systems and learning environments integrate Web 2.0 advantages and tools. An example are PLEs. Traditionally, a PLE is a set of lightweight services and tools controlled by individual learners. These tools and services are not integrated into a centralized system; the learner rather selects and uses tools and services of his/her choice from a myriad of tools/services available. The new generation of PLEs put emphasis on (Jeremic et al. 2013): learners' social interaction and collaborative exchange; creating new meaning through interaction (annotation, linking and aggregation) with existing learning resources; informal learning; the use of existing vocabularies (such as Linked Open Data, <http://linkeddata.org/>) and services (such as DBpedia Spotlight, <http://dbpedia.org/spotlight>) for annotation of learning resources; and on openness, contextualized learning, and ubiquitous data access.

An interesting question here is: What is the nowadays focus of interest of researchers working in applying Semantic Web / Web of Data / Linked Data in education? After browsing a number of relevant open resources (journals, conference proceedings, workshop announcements, etc.), talking to fellow researchers and friends, and asking informally several experts for their opinions, I have a feeling that the topics in focus overlap to an extent with those of modern PLEs: interoperability, reuse and integration of learning resources, contextualized learning, learning personalization, and informal learning. This is probably good, since it might indicate that somewhat different communities approach similar topics (from somewhat different angles and with different objectives). It also indicates the impact that Semantic Web ideas have made on the PLE community, since historically these interests have existed in the Semantic-Web-in-education community before PLEs have become popular.

A small, but rather representative set of research papers on Linked Data in education is that from the highly appreciated series of workshops called Linked Learning (<http://ceur-ws.org/Vol-1254/>, <http://www2013.org/papers/companion.htm#5>, <http://www.ceur-ws.org/Vol-840/>). In a way, the Linked Learning workshops have filled the gap that has been created after the workshop series Semantic Web for e-Learning (SWEL), which were organized from 2002 to 2010, ceased to exist.

But make no mistake: although Linked Data is a more realistic vision than that of the original Semantic Web, it still puts a lot of practical challenges for those who venture in applying it in education. For example, what about the quality/correctness/completeness of Linked Data? Does educational community at large agree on the data sources and

vocabularies used on the Web of data? Are these sources stable and persistent, or rather volatile? How easy (difficult?) and how effective it is to annotate existing learning resources with existing vocabularies? Along similar lines, Faqihi et al. (2013) discuss how ontologies, semantic services, semantic interoperability, reuse, and semantic search can enter cloud-based education, but also note the complexity of achieving this objective.

Speaking Words of Wisdom

In 2009, I met Dr Wolfgang Geisler, a retired researcher and engineer from Volkswagen, a well-known German car-production company. At a research project meeting that we attended, he said that researchers should better look at existing problems and needs of practitioners first, rather than doing research that practitioners might not be interested at.

I think that these words explain why the Semantic Web hype, especially at the peak of inflated expectations on the diagram in Fig. 1 and during the disillusionment period, has got the reputation of “a solution looking for a problem”. They also indicate why Semantic Web has failed to attract interest from industry, as well as to produce a “killer application” for business, education, or any other sector.

Along the same line, albeit on a more extreme side, another well-known researcher has told me that he never uses social bookmarking tools: “For everything I need, I just ask Google and it shows me”, he said. I am a Diigo addict (<https://www.diigo.com/>), but I must admit that I did reflect on what he said. Also, take a look at the frequently updated Top 100 Tools for Learning list (<http://c4lpt.co.uk/top100tools/>). Do you recognize any Linked Data tool there? Do you think that people who use those top 100 tools can be convinced easily that they need Linked Data that is still emerging?

Highway 61 Revisited

After the t_2 point, during the slope of enlightenment in Fig. 1, I have participated in several research projects related to applying Semantic technologies in education (see, e.g., <http://op4l.fon.bg.ac.rs/> and <http://www.intelleo.eu/index.php?id=2>). Good-quality ontologies, ontological frameworks and tools have been developed in these projects, but the results of these projects did not make a notable impact so far. Still, these projects have helped me clarify one thing related to Semantic Web / Linked Data in education: Linked Data can only be the *infrastructure*, and infrastructure never sells as such. There must be something else *on top of it* in order to sell it, and even then it is the other thing that sells, not the infrastructure.

You Won't See Me In other words, if big industry wraps a useful infrastructure into its product, it might sell. Take a look at the Google Knowledge Graph (<http://www.google.com/insidesearch/features/search/knowledge.html>). It does use Linked Data principles, as well as vocabularies such as those from Schema.org (<http://schema.org/>), but it does not sell *them*. It sells knowledge, learning, connected information, easier navigation, meaning, etc., all wrapped up in the results of ordinary search queries. Similarly, a vast

majority of Facebook users does not have a clue of the existence of Open Graph Protocol, OGP (<http://ogp.me/>); they just see those cool little things on Facebook as effects of Web pages annotated with OGP metadata (which are based on RDFa). These two examples belong to the plateau of productivity of Semantic technologies in Fig. 1, although here these technologies work in the background.

The Times They are A-Changin’ In any research area, hot topics come and go. At the time of writing this article, the current fad in our area is Learning Analytics and there is a considerable hype about it. It is not until the hype settles down that one can judge objectively about the impact of the results achieved by pursuing the corresponding research topic. To this end, Semantic Web in education is somewhat controversial. On the one hand, there is no excitement about it anymore, and few researchers would recommend a novice PhD candidate to pick for her/his thesis a topic from that area. On the other hand, I don’t think that Google and Facebook are investing in Linked Data technologies without any vision. I also remember other AI technologies that were once hot, then dismissed, but resurrected again (e.g., neural networks), and those that returned disguised under a different name and equipped with some new technology (e.g., expert systems / recommender systems).

Coda

At an international conference held in August 2014, I met Elvira Popescu from Romania, a very active researcher in the area of Web-based learning. She told me that she had recently read my book on Semantic Web in education (Devedzic 2006). Her comments were very positive, and I could clearly see that she meant it. I was pleased and proud, but also a bit surprised that researchers are still interested in it. And it was developed starting from *Education and The Semantic Web*.

A couple of weeks later, there came the invitation from Vincent Aleven and Judy Kay to write this article. I was surprised again. They explained that *Education and The Semantic Web* was one of those IJAIED papers cited 100 times or more. Wooowww! What’s going on, am I missing something here?!?!

Ten years after *Education and The Semantic Web*, it seems that its key practical contribution was stressing “the need for making future AIED systems better engineered than current ones”. This quotation from the original paper was implicitly addressed in much of the developments that followed, as the focus of attention has shifted from *imagine* systems to systems that *work*. And I think it should stay that way. Perhaps the way to “sell” Semantic Web in education is to follow the aforementioned approach from Google and Facebook—enrich *another* great idea / technology / category of learning systems and resources with ontologies, semantic search and Web of data. And we do have these *other* things around (PLEs, OERs, MOOCs, learning analytics, etc.). To this end, I would suggest to always have another two perspectives when developing Semantic Web / Web of Data / Linked Data systems to be used in education: do educators and learners *need* these systems, and is there somebody who really wants to *use* them? Other than that... don’t think twice, it’s alright.

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